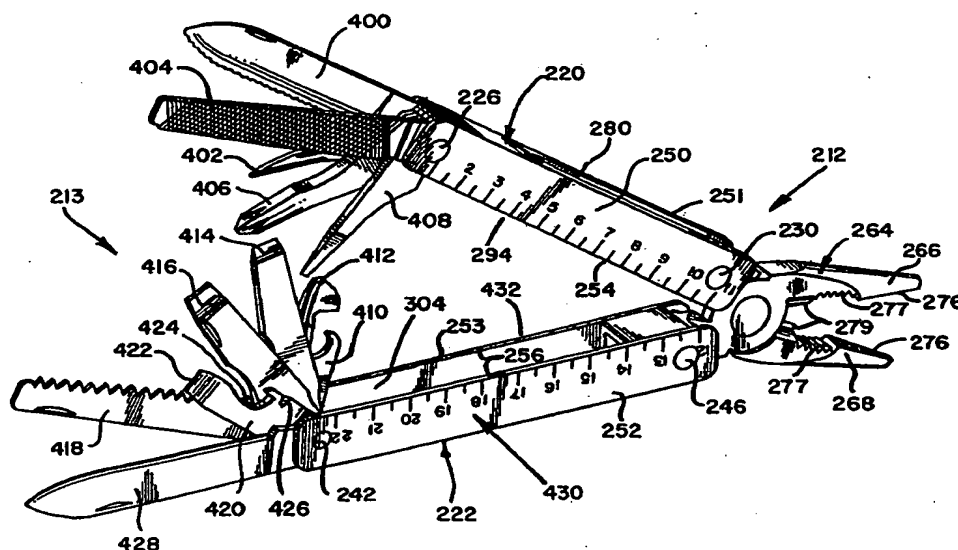


INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : B25B 7/22	A1	(11) International Publication Number: WO 98/18599 (43) International Publication Date: 7 May 1998 (07.05.98)
<p>(21) International Application Number: PCT/US97/02185</p> <p>(22) International Filing Date: 4 February 1997 (04.02.97)</p> <p>(30) Priority Data: 739,707 29 October 1996 (29.10.96) US</p> <p>(71) Applicant (for all designated States except US): VICTORINOX [CH/CH]; Schmiedgasse 57, CH-6438 Ibach (CH).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): HARRISON, Marc [US/US]; 568 Bristol Ferry Road, Portsmouth, RI 02871 (US). ELSENER, Carl, S. [CH/CH]; Rainweg 15, CH-6438 Ibach (CH). ELSENER, Eduard, A. [CH/CH]; Gutschweg 12, CH-6440 Brunnen (CH). ROHRER, Albert, F. [CH/CH]; Oberfeld 35, CH-6430 Schwyz (CH). ROHRER, Walter, X. [CH/CH]; Mangelegg 123, CH-6430 Schwyz (CH). GIARRITTA, Franco [CH/CH]; Baumgartenstrasse, CH-6432 Rickenbach (CH). ROPER, Riddell [CH/CH]; 2nd floor, 40 Dexter Street, Providence, RI 02909 (US).</p> <p>(74) Agents: SZCZECINA, Eugene, L., Jr. et al.; Darby & Darby P.C., 805 Third Avenue, New York, NY 10022 (US).</p>	<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report.</p>	

(54) Title: MULTIPLE FUNCTION TOOL



(57) Abstract

A multiple function tool (12) having first and second handles (20, 22), a tool head (64) with pivotal jaw members (66, 68), and a plurality of additional tools. The tool head (64) is stored within first channels on first sides (54, 56) of the handles, and the additional tools are stored within second channels (60, 62) on second sides of the handles opposite the first sides. Thus the additional tools do not interfere with gripping of the handles (20, 22). Moreover these tools are easily accessible while the tool head (64) is in the storage position. The compound tool (12) may also include a ratchet (32) and an adapter (152) and coupler that fit on the ratchet. A straight edge ruler (430, 432) may optionally be provided on the top and bottom surfaces of the handles. Preferably, an individual spring (440) is provided for each tool to prevent pivoting away from the storage channels once the tool is extended. A lock mechanism (450) may be provided.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

5

MULTIPLE FUNCTION TOOLBACKGROUND OF THE INVENTION

10 1. Field of the Invention

The present invention relates to a multiple function, compound tool. More particularly, the present invention relates to a combination tool having a tool head with jaw members foldable into channels in the handles and other
15 tools pivotable from a position within other channels of the handles to a position that provides optimum usability of the selected tool.

20 2. Discussion of the Related Art

Compound, multiple function tools having foldable handles and at least one tool with jaws foldable into the handles are known in the art. Typically, the pliers, or other tool having a pivotable jaw, have a pivot axis and tangs extending from the pivot axis in a direction opposite
25 from the jaw. The tangs are pivotally coupled to the handles. Prior art combination tools have shown jaws that are pivotable about their tangs, either about an axis parallel to the pivot axis of the jaws, or an axis perpendicular to the jaws' pivot axis. Prior art combination tools have also
30 shown jaws that are slidable along the handles of the tool to retract into a channel within the handles.

Multi-function, compact tools typically also include a variety of other tools that may be pivoted into
35 and out of a channel within the handle of the tool for selective use. However, multi-function tools that include a tool having jaw members, such as pliers, typically do not permit access to the remaining tools without opening the handles to also extend the jaw members. Thus, access of a

tool other than the pliers often requires more than the single step of extending the desired tool. Moreover, many of such selectable tools are not in an optimum using position when extended out of their respective handles. The
5 selected tool (screwdrivers, in particular) is often in an awkward using position and is generally not aligned to have the greatest amount of centerline force transmitted from the user's hand and arm to the tool. Cutting tools generally are positioned so that a barrier is created by the handles
10 such that the entire length of the sharp edge is not readily usable. Typically, such a barrier is created by having the sharp edge face between the handles and thus spaced from the sides of the tool where the object to be cut, sliced, sawed, etc., is positioned.

15 Another disadvantage with pivoting of certain models of such tools into and out of their respective channels for use is that once a tool has been extended and locked in place (for those tools that have locks), typically another tool must be extended at least half way to permit
20 the first tool to be replaced into the storage position within its respective channel.

Although combination tools provide a variety of different tools, the user is generally limited in the number of different tools that are available from a given combination tool. For instance, generally only one size of a given
25 tool is provided. Additionally, certain tools, such as ratchets, generally are not provided in combination tools.

SUMMARY OF THE INVENTION

30 It is therefore an object of the present invention to provide a multiple function, compound, compact tool having at least one tool with jaw members retractable into the handle of the tools, and a variety of other tools pivotable into and out of channels within the handles while the
35 jaw members remain in a stored position, retracted within the handles. Likewise, when the jaw members are extended into a useable position, it is an object of the present invention to have the remaining tools out of the way so that

comfortable gripping of the handles during jaw member use may be achieved.

It is a related object of the present invention to provide a foldable tool having jaw members easily retract-
5 able into the handles of the tool.

It is a further object of the present invention to provide a multiple function tool having a variety of tools extendable, from a retracted position within the handles of the tool, to an optimum position for use such that the full
10 working length of the tool is available and conveniently located, and the axes of the rotating tools are substantially aligned with the centerline of the handles of the tool so that force is substantially directly transmitted along the centerline from the user's hand and arm to the tool.

It is yet another object of the present invention to provide a multiple function tool that permits the tools to be interchangeable, or at least modifiable for different
15 uses or sizes, and also provides tools and features that are not typically provided in compound tools, such as a mechanical reversible ratchet.
20

It is yet another object of the invention to provide a spring mechanism that permits pivoting of individual tools between a storage position and a working position without affecting adjacent tools. Preferably, the spring
25 mechanism also permits individual locking of the tools in either a straight position or a working position.

These and other objects of the present invention are accomplished in accordance with the principles of the present invention by providing a compact, foldable, multiple
30 function tool having a tool with jaw members retractable into a first storage area of the handles of a tool, and a plurality of different tools retractable into a second storage area of the foldable handles. The tool with the jaw members preferably is a set of pliers having a jaw pivot
35 axis and tangs extending from the jaw pivot axis away from the jaw members. The handles are pivotable along an axis through the tangs substantially parallel to the jaw pivot axis. The jaw members have a working surface formed by the

opposing faces of the jaw members, and an outside surface facing away from the working surface. The handles have a working surface, substantially aligned with the outside surface of the jaw members, which surface is gripped during use of the jaw members when the handles are unfolded. The jaw members are stored within channels in these working surfaces of the handles, the outside surfaces of the jaw members being nested within the channels. The handles also include a second surface facing the same side as the working surface of the jaw members, which therefore form an inner surface when the handles are extended to use the jaw members, but an outer grip surface when the handles are folded to make the tool compact, and comfortable to grip.

Another channel is provided in each handle of the tool opposite the channel in which the jaw members are stored, and a variety of other tools may be stored within these additional channels. The other tools are accessible and extendable for use even when the jaw members are still in their retracted, stored position. Thus, the handles may be in a folded position when these other tools are used, so that the handles, together, form a single handle for these other tools. These additional tools are pivotable along a pivot axis substantially parallel to the pivot axis of the jaw members and the tangs, but preferably are connected to an end of the handles opposite the connection point of the jaw members. The shank of each of the tools is preferably designed such that the working area of the tool is in an optimum working position. Thus, at least some of the tools that require rotation are preferably substantially aligned with the central longitudinal axis of the folded handles that form the gripping area of the tool and also are preferably longer than prior art tools and the other tools of the multi-tool. Likewise, cutting tools are preferably designed such that the cutting area is at the most accessible position for cutting, slicing, sawing. etc., an object. Additionally, the handles may be provided with full-length (i.e. 1 inch) rulers that are disposed adjacent to straight free edges.

The multiple function tool of the present invention preferably includes modular components that are positionable and various ones of the pivotable tools to permit the tools that are integral to the compound tool to be modified for other uses. Preferably, an adapter is provided that may be fit on the heads of the tools that are integral to the compound tool. Additional tools may then be positioned on the adapter and used with the compound tool. Additionally, a mechanical reversible ratchet is provided in which a variety of such additional tools may be fit for 90° to the handle socket and tip applications and rotations for clockwise or counterclockwise rotations.

A further feature of the tool of the present invention, is the provision of an individual spring for each tool pivotally connected to the handles. The spring locks the individual tool in its working position by preventing further pivoting of the tool away from its storage position. Furthermore, the individual springs permit repositioning of the tools in the storage position without affecting the position of adjacent tools. A spring lock may be provided to provide an additional lock for the tools to prevent the tools from moving back into the storage position when in the working position. Only when the spring lock is moved may the tool be replaced into the storage position.

These and other features and advantages of the present invention will be readily apparent from the following detailed description of the invention taken in conjunction with the accompanying drawings wherein like reference characters represent like elements, the scope of the invention being set out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a tool set having a compact multiple function tool and a set of adapters and additional heads for use with the multiple function tool, the tool and the adapter and tool heads being positionable within a case in accordance with the principles of the present invention;

Fig. 2 is a cross-sectional view along line 2-2 of Fig. 1, showing the multiple function tool, adapter, and additional heads in place within the case;

Fig. 3 is a top elevational view of a compact multiple function tool formed in accordance with the principles of the present invention;

Fig. 4 is a cross-sectional view of the tool of Fig. 3, showing a variety of tools nested within the handles of the compact tool;

Fig. 5 is a cross-sectional view along line 5-5 of Fig. 4 showing a plan view of the interior side of the tool of the present invention;

Fig. 6 is an isolated perspective view of an inclined tool jaw pocket formed in a handle of the tool of the present invention;

Fig. 7 is an elevational view of the tool of the present invention shown in an unfolded configuration with a tool having a jaw member being in an extended position;

Figs. 8 and 9 are sequential elevational views of the tool of the present invention being folded into a compact configuration;

Fig. 10 is a side elevational view of the tool of the present invention in a folded configuration;

Fig. 11 is a side elevational view of the other side of the tool shown in Fig. 8;

Fig. 12 is a top elevational view of the tool of the present invention in a folded configuration, but with first and second tools in extended positions;

Fig. 13 is a view similar to that of Fig. 12, but with another tool in an extended position;

Fig. 14 is a view similar to that of Fig. 12, but with yet other tools in an extended position;

Fig. 15 is a top elevational view of the tool of the present invention in a folded configuration, but with partially cut-away portions showing the internal mechanism of the ratchet of the tool, the ratchet being in a first operative position;

Fig. 16 is a view similar to that of Fig. 15, but

with the ratchet in a second operative position;

Fig. 17 is a perspective view of the tool of the present invention, showing various adapters and additional tool heads that may be used with the tool of the present invention;

Fig. 18 is a perspective view of the tool of the present invention in a folded configuration, and with an adapter positioned within the ratchet and a hex socket in position for use on the adapter;

Fig. 19 is a perspective view of a variation of the multiple function tool of Figs. 1-18;

Fig. 20 is an elevational view of the multiple function tool of Fig. 19 in position for use as a ruler;

Fig. 21 is a perspective view of the multiple function tool of Fig. 19 in position for use as a right angle with individual blade springs shown;

Fig. 22 is a cross-sectional view, along line 22-22 of Fig. 21, of one of the handles of the multiple function tool of Fig. 21;

Fig. 23 is an isolated cross-sectional view of a handle of the multiple function tool of Fig. 21 showing a tool partially withdrawn from a storage position and the action of individual blade springs;

Fig. 24 is an isolated cross-sectional view similar to that of Fig. 23, but with the tool fully withdrawn into a usable position;

Fig. 24A is an elevational view of a handle of the multiple function tool shown in Fig. 24, but with a side removed to reveal the formation of spring elements therein;

Fig. 25 is a front elevational view of a multiple function tool in accordance with the principles of the present invention having a spring lock mechanism;

Fig. 26 is a cross-sectional view, along line 26-26 of Fig. 25, of a handle of the multiple function tool of Fig. 25;

Fig. 27 is a cross-sectional view along line 27-27 of Fig. 26, showing the functioning of the spring lock

mechanism;

Fig. 28 is a cross-sectional view along line 28-28 of Fig. 26, showing a tool in a storage position and the spring lock mechanism in a neutral position;

5 Fig. 29 is an isolated cross-sectional view similar to that of Fig. 28, but showing a tool partially withdrawn from a storage position;

Fig. 30 is an isolated cross-sectional view similar to that of Fig. 29, but showing the tool in a completely
10 withdrawn and locked position;

Fig. 31 is a cross-sectional view, along line 31-31 of Fig. 22, of a one-piece handle of a multiple function tool of the present invention;

Fig. 32 is a view similar to that of Fig. 22, but
15 showing a two-piece handle; and

Fig. 33 is a cross-sectional view, along line 33-33 of Fig. 32, of a two-piece handle of a multiple function tool of the present invention.

20 DETAILED DESCRIPTION OF THE INVENTION

A multiple function tool set 10 formed in accordance with the principles of the present invention is shown in Fig. 1. Tool set 10 includes a compact, foldable, multiple function tool, or "multi-tool" 12, an adapter set 14,
25 and a carrying case 16. Multi-tool 12 and adapter set 14 fit within case 16, as shown in Fig. 2.

Multi-tool 12, shown in the top elevation view in Fig. 3, has a first handle 20 and a second handle 22. First handle 20 has a first, proximal end 24 having a proximal
30 pivot axis 26, and a second, distal end 28 having a distal pivot axis 30. Optionally, first handle 20 also includes a ratchet 32 with ratchet control knob 34 and an additional pivot axis 36, as will be described in greater detail below. The longitudinal axis of first handle 20 may be defined as
35 substantially parallel to a line through proximal pivot axis 26 and distal pivot axis 30. Second handle 22 likewise has a first, proximal end 40 having a first, proximal pivot axis 42, and a second, distal end 44 having a second, distal

pivot axis 46. The longitudinal axis of second handle 22 may be defined as substantially parallel to a line through proximal pivot axis 42 and distal pivot axis 46. The longitudinal axis of the handles, together, is equidistant from and substantially parallel to the longitudinal axes of the individual handles. Pivot axes 26, 30, 42, and 46 preferably extend from the top surfaces 50, 52 of handles 20, 22, respectively, to the respective bottom surfaces 51, 53.

Each handle 20, 22 further includes a respective exterior first sides 54, 56, forming exterior sides of the handles when multi-tool 12 is in the folded configuration (See Figs. 3 and 4). The top surfaces 50, 52, the bottom surfaces 51, 53 (Figs. 10 and 11), and the exterior sides 54, 56 form a gripping surface 58 for the multi-tool 12 when in the folded configuration shown in Fig. 3. As can be seen in Figs. 1, 10, 11, 17 and 18, first sides 54, 56 are substantially open to allow access to a plurality of tools 13 nested within the handles. Although first sides 54, 56 may be slightly bowed outwardly, as shown in Fig. 3, to provide a comfortable grip, if a ruler is provided on top surfaces 50, 52 and/or bottom surfaces 51, 53 as in the embodiment of Figs. 19-21 (described in further detail below), first sides 54, 56 are most preferably straight edges. First and second handles 20, 22 further include respective second sides 60, 62 that face each other when multi-tool 12 is in the folded configuration and thus may be considered interior sides as shown in Fig. 3. Second sides 60, 62 have a sufficiently smooth closed surface to form a uniform gripping surface 59 together with the top surfaces 50, 52 and the bottom surfaces 51, 53 when in the unfolded configuration (see Fig. 7). As may be understood from a review of Figs. 4, 7, and 10-12, the multiple tools of multi-tool 12 are nested within and extracted from either the first sides 54, 56 or the second sides 60, 62 of the handles.

Multi-tool 12 includes a tool head 64, such as a set of pliers, having pivotable jaw members 66 and 68 pivotable along jaw pivot 70. Tool head 64 is nested in channels along second sides 60, 62 that form interior sides of the

handles 20, 22 when in the folded configuration such that tool head 64 is substantially hidden from view in the folded configuration shown, for example, in Figs. 3 and 4.

Jaw member 66 preferably includes a tang 72 pivotally connected to second handle 22 along distal pivot axis 46. Jaw member 68 likewise preferably has a tang 74 pivotally connected to first handle 20 along distal pivot axis 30. Preferably distal pivot axes 30 and 46 are substantially parallel to jaw pivot 70 such that jaw members 66, 68 pivot with respect to handles 20, 22 along an axis substantially parallel to their pivot axis 70. As may be seen in Fig. 4, jaw members 66, 68 of tool head 64 are nested along second sides 60, 62 of handles 20, 22. As may be seen in Fig. 5, jaw member 68 has first and second gripping surfaces 76, 77 provided with a plurality of fine teeth, preferably extending parallel to each other and laterally across jaw member 68. In the preferred embodiment, tool head 64 is a set of pliers, and gripping surface 76 is at the distal-most, pointed section of jaw 68. Preferably, as may be seen, for example, in Fig. 4, each jaw member 66, 68 also includes a sharp edge 78, edges 78 together forming a wire

cutter 79. It will be understood that jaw 66 is substantially similar to jaw 68.

Jaw members 66 and 68 are nested in respective tool head channels 80, 82 in the second sides 60, 62 of respective first and second handles 20, 22 as may be seen in Figs. 4 and 5. The distal, pointed end 67, 69 of each jaw member 66, 68 is preferably nested within the specially configured inclined pockets or inclined planes 86, 88, as may be seen in Figs. 4 and 5. Pocket 88 is shown in more detail in Fig. 6. Each pocket 86, 88 is inclined to facilitate folding and sliding of tool head 64 within the interior surfaces of handles 20, 22, as shown in Figs. 8 and 9, upon pivoting the handles about their respective distal axes 30, 46 to fold multi-tool 12 from an unfolded configuration (as shown in Fig. 7) into its compact, folded configuration (shown, for example, in Figs. 3 and 4). As may be seen in

Figs. 8 and 9 (which sequentially show the folding of multi-tool 12 such that tool head 64 is nested within handles 20, 22) the distal ends 67, 69 of jaw members 66, 68 are the first parts of tool head 64 to enter tool head channels 80, 82. Distal ends 67, 69 first contact inclined pockets 86, 88, as shown in Fig. 8. The inclination of pockets 86, 88 facilitates smooth sliding and positioning of jaw members 66, 68 within pockets 86, 88, as shown in Fig. 9, and hence smooth positioning of tool head 64 within tool head channels 80, 82 for storage. Preferably, a self-lubricating material is used at pockets 86, 88 to further facilitate sliding of jaw members 66, 68 therealong. Inclined jaw pockets 86, 88 may be formed from the tool head channels material or by the separate spring and/or locking devices.

When first and second handles 20, 22 are pivoted about their respective distal axes 30, 46 to open multi-tool 12, tool head 64 is extended from its retracted position into a usable position, such as shown in Fig. 7. Second sides 60 and 62 are thereby exposed to face outwardly, away from each other, and first sides 54, 56 are thereby positioned at the inside of the tool, facing each other in this configuration for use of the tool head 64. As may be seen in Fig. 4, 8 and 9, and more clearly understood from reviewing Fig. 7, second sides 60, 62 of first and second handles 20, 22 further include grip surfaces 90, 92 to facilitate gripping of handles 20, 22 in utilizing tool head 64. Accordingly, even though handles 20 and 22 have open channels 80, 82 in which jaw members 66, 68 are respectively nested, smooth surfaces 90, 92 are provided so that a user may comfortably grip handles 20 and 22 during use of tool head 64. Surfaces 90, 92 may be bowed or textured or coated or otherwise formed to increase user comfort during gripping.

As may be seen, for example, in Figs. 4 and 7, additional tools 13 are nested within handles 20, 22 adjacent first sides 54, 56, respectively, which are exterior sides when handles 20, 22 are folded (as in Fig. 3) but which face each other when tool head 64 is in a usable

position, as in Fig. 7. Thus, when multi-tool 12 is in the folded configuration of Fig. 3, tools 13 are easily accessible because they are accessed through exterior first sides 54, 56 of handles 20, 22. However, when tool head 64 is used, tools 13 are not easily accessible and therefore do not interfere with the gripping of handles 20 and 22 during use of tool head 64.

A variety of tools may be provided in handles 20, 22, as illustrated in Figs. 10-14. Exterior first side 54 of first handle 20 is shown in Fig. 10. An interior nesting channel 94 is formed between top side 50, bottom side 51 and interior second side 60 of first handle 20. Such tools as a saw 96, file 98, and a long thin screwdriver 100 (to facilitate access to difficult spaces) may be pivotally coupled to first handle 20, within tool channel 94 via pivot axis 26. An additional tool such as a pick or awl 102 may be pivotally connected within channel 94 via additional pivot axle 36. Pick or awl 102 is shown in the extended position in Fig. 12. Ratchet 32 is preferably positioned on first handle 20 and will be discussed in greater detail below.

Additional tools are positioned within tool channel 104 formed in second handle 22, between top side 52, bottom side 53, and interior second side 62, and accessible through first exterior side 56 as shown in Fig. 11. Exemplary tools include a cutting blade 106, a can opener 108, a Phillips head screwdriver 110, a cap lifter/screwdriver 112, and a scissors 114 pivotally connected within tool channel 104 via pivot axis 42. It will be understood that various modifications to the tools 13 shown in the Figs. may be made, such as to the length or width/diameter of the shanks of the tools. It will be further understood that tools different from or in addition to or in different positions from the ones shown may be provided in either of tool channels 94 and 104, such as shown in the embodiment of Figs. 19-21 described in further detail below. Accordingly, pivot axes 26, 42 may be removed by the user with an appropriate tool in order to replace, change, or reposition the tools or blades.

In accordance with the principles of the present invention, the tools that are pivotally connected to handles 20, 22 within tool channels 94, 104 are preferably shaped to provide optimal usage when extended into a working position. Specifically, as shown in Figs. 12 and 13, respective shanks 116, 118 of screwdrivers 100, 110 are angled such that the heads of the screwdrivers are positioned as close to the interior of the handle formed by handles 20, 22, i.e., the heads of screwdrivers 100, 110 are as close to interior sides 60, 62 as possible and therefore as close to the longitudinal axis of the handles, when held together, as described above. Thus, any force applied to screwdrivers 100, 110 via the handles 20, 22 is transmitted substantially directly to the tool head with as little moment arm, and thus as little loss of applied force, as possible. The same is preferably true for the other tools 13.

Exemplary blade 114 and exemplary saw 96 are shown in extended positions in Fig. 14. The cutting tools of the multi-tool 12 are also positioned and connected to handles 20, 22 for optimal use in the extended position. Thus, blade edge 120 is positioned as close to exterior first side 56 as possible to facilitate cutting with slicing type blade 114. Likewise, serrated edge 121 of saw 96 is positioned as close to exterior first side 54 as possible to facilitate sawing with saw 96. A notch or groove 122 is provided to assist a user in grasping blade 114 or saw 96 from within tool channel 104, 94 to position blade 114 or saw 96 in the extended, usable position shown in Fig. 12. It will be understood that other tools of multi-tool 14 may include similar notches 122.

Multi-tool 12 may be provided with a mechanical reversing ratchet 32, positioned within first handle 20. The internal mechanism of ratchet 32 is shown in Figs. 15 and 16. Ratchet 32 includes a ratchet wheel 124 alternately engaged by one of pawls 126, 128, which pawls are disposed on lever 130. Lever 130 includes a lever switch 132 for selecting which of pawls 126, 128 is to engage ratchet wheel 124. A biasing member or unit 134, such as a spring and

ball, or leaf spring, or other detente device, is provided to maintain the selected pawl 126, 128 in its engaged position with ratchet wheel 124. When pawl 126 is engaged with ratchet wheel 124, as shown in Fig. 15, ratchet 32 is usable only in the counterclockwise position. Pawl 126 is shaped to prevent clockwise rotation of ratchet wheel 124. As shown in Fig. 16, when pawl 128 is engaged with ratchet wheel 124, ratchet 32 moves only in the clockwise position. Pawl 128 is likewise shaped to prevent rotation of ratchet wheel 124 in the opposite direction, in this case, counterclockwise rotation.

Referring now to Fig. 17, ratchet 32 is preferably provided with a socket 136 shaped to fit a variety of tool heads 138. Exemplary tool heads 138 include a variety of tips, such as a star-shaped tip 140, a hex tip 142, a square-shaped tip 148, another sized hex tip 144 and a screwdriver tip 146. Square-shaped tip 148 may function as an adapter that fits into socket 150 of adapter 152. Adapter 152 includes an additional adapter socket 154 in which shanks 156 of additional tool heads 158 may fit. Adapter 152 may be magnetic, if desired, to provide a more secure coupling. Adapter 152 is thus provided to permit tool heads 158 to extend the length of the tools that are pivotally coupled to multi-tool 12. Tool heads 158 may include a variety of different sized sockets 160, 162 for use as socket wrenches, and phillips screwdriver 164. An exemplary socket 162 is shown connected to ratchet 32 via adapter 152 and 148 in Fig. 18.

Phillips screwdriver 110 that is pivotally connected within tool channel 94 of first handle 20 is preferably provided with a substantially square distal portion 166 of shank 118 that may be fit within square socket 150 of adapter 152 (Fig. 17). Accordingly, different tool heads, such as screwdriver tool head 168, may be positioned on shank 118 to provide a non-ratcheting tool different from the ones that are pivotally connected to and form an integral part of multi-tool 12. Moreover, adapter 152 may thus function as an extender to thereby provide longer tools for

accessing difficult to reach areas.

Tools and tips that are smaller and larger than adapter 154 may also be provided either with adapter set 14 or as an optional accessory pack. The distal portions of
5 others of tools 13 may similarly have a square cross-section. Tool heads 138, 156 and adapter 152 may be stored on adapter set 14 and can be fit, together with multi-tool 12, within case 16, as shown in Figs. 1 and 2.

As described above, multi-tool 12 may be provided
10 with additional or alternative tools, such as multi-tool 212 of Figs. 19-21. Elements of multi-tool 212 that correspond to elements of multi-tool 12 are labeled with reference numerals used with respect to multi-tool 12 increased by 200. Multi-tool 212 includes tool head 264, preferably in
15 the form of pliers, pivotally coupled to respective handles 220, 222 via respective pivot axes 230, 246. Tool head 264 preferably includes wire cutter 279 in addition to gripping surfaces 276, 277. As in multi-tool 12, multi-tool 212 is foldable into a compact configuration similar to the configuration of multi-tool 12 shown in Fig. 3. Upon folding
20 multi-tool 212 into a compact configuration, jaw members 266, 268 of tool head 264 are nested within tool head channels 280, 282 of respective handles 220, 222. Jaw pockets such as those provided in multi-tool 12 may also be provided in
25 multi-tool 212.

Once multi-tool 212 is folded such that tool head 264 is in a stored position, the additional tools 213, stored in channels 294, 304, are readily accessible. Such additional tools as serrated blade 400, reamer and punch
30 402, metal saw and metal file 404, phillips head screwdriver 406, and screwdriver 408 (preferably a small sized screwdriver, e.g., approximately 2mm) may be pivotally connected to handle 220 via pivot axis 226 and storable within channel 294. Such additional tools as combination screwdriver can
35 opener 410 (having screwdriver edge 412 preferably approximately 3mm long), chisel/scrapper 414, large sized screwdriver 416 (preferably approximately 7mm), wood saw 418; combination tool 420 having a medium sized screwdriver head 422

(preferably approximately 5mm), a cap lifter 424, and a wire stripper 426; and a large blade 428 may be pivotally connected to handle 222 via pivot axis 242 and storable within channel 304. Pivot axes 226 and 242 may be removed by the user with an appropriate tool in order to replace, change, or reposition the tools or blades. It will be understood that additional tools, such as scissors, a lanyard loop, a fish scaler or a corkscrew, may be provided instead or in addition to the tools shown. Additionally, handle 222 may be provided with a ratchet similar to ratchet 32 of multi-tool 12, with similar attachments as described with reference to the above-described multi-tool 12 embodiment.

In addition to tools 213, multi-tool 212 may also be provided with a metric ruler 430 on top surfaces 250, 252 of handles 220, 222, and a full length (e.g. 12 inches) English ruler 432 on bottom surfaces 251, 253. Preferably, the marks of the rulers 430, 432 are adjacent first sides 254, 256. Accordingly, as mentioned above, when rulers are provided on handles 220, 222, preferably straight edges are also provided (by forming first sides 254, 256 straight, rather than bowed) such that rulers 430, 432 may be read right up to the edges to facilitate accurate reading of the side of the measured item). As shown in Fig. 20, handles 220, 222 may be extended to be substantially collinear such that the full extent of ruler 432 may be used. Alternatively, handles 220, 222 may be positioned at right angles, such as shown in Fig. 21, to provide a right angle with multi-tool 212 for measurement or other purposes.

Another feature of multi-tool 212 that facilitates use of additional tools 213 (in addition to the position of the tools 213 for removal from the first sides 254, 256 when multi-tool 212 is in the compact, folded configuration) is the provision of an individual spring for each individual tool. An individual spring 440 associated with exemplary blade 428 is shown in Figs. 22-24, Fig. 22 being a cross-section along line 22-22 in Fig. 21 of handle 222. It will be understood that the description of spring 440 may be applied to any of tools 213. Blade 428 is in nested posi-

tion within channel 304 of handle 222 as shown in Fig. 22. Upon withdrawal of blade 428 from within channel 304, resilient end 442 of spring 440 (adjacent pivot end 444 of blade 428, which is pivotally connected to handle 222 via pivot axis 242) flexes outwardly as shown in Fig. 23. The free end of resilient end 442 of spring 440 is provided with tooth 446 and pivot end 444 of blade 428 is provided with a notch 448 for receiving tooth 446 when blade 428 is in the fully extended position shown in Fig. 24. Thus, blade 428 is prevented from further rotation away from channel 304, such that application of force to blade 428 during cutting, slicing, etc., is transmitted to the blade to perform the desired task without causing further rotation of blade 428. The radius of curvature of first end 444 is selected to provide sufficient resistance to opening, yet does not unduly restrict opening. If desired, the radius of curvature may vary to produce a desired change in resistance to opening/closing. Although, springs 440 may be formed as separate elements, it is simpler to manufacture springs 440 from a single plate 441 having a plurality of cuts 443 separating plate 441 into springs 440. (See Fig. 24A).

A further modification to the spring feature shown in Figs. 22-24 is the provision of a spring lock 450 on multi-tool 212', as shown in Figs. 25-30. Spring lock 450 may be used with springs essentially the same as spring 440 of Figs. 22-24. Accordingly, the spring in Figs. 25-30 is labeled as spring 440 with tooth 446 at its resilient end 442. It will be understood that spring lock 450 may be applied to a spring 440 of any of the tools of the multi-tool, reference being made herein to only blade 428 for the sake of simplicity. As may be seen in Fig. 26, which is a cross-sectional view along line 26-26 of Fig. 25, spring lock 450 is positioned below spring 440, for reasons as will be understood with reference to Figs. 28-30. Spring lock 450 is biased by a biasing spring 452 fitted against curved end 454 of spring lock plate 456 of spring lock 450 and post 458, as shown in Fig. 27, which Fig. is a cross-sectional view along line 27-27 of Fig. 26. Biasing spring 452 is

illustrated in Fig. 27 in an extended position in solid lines to bias spring lock plate 456 to the left against an end of an extended tool, as will be described in further detail below. Post 458 provides a surface, which is fixed with respect to the handle, against which biasing spring 452 may be biased upon moving spring lock plate 456 to the right, as shown in phantom in Fig. 27, and as will be described in further detail below. Biasing spring 452 may be a leaf spring, as shown, or any other spring that would provide the desired biasing effect.

As may be seen in Fig. 28, which shows a cross-sectional view along line 28-28 of Fig. 26, pivot end 444 of blade 428 is provided with a partially cut away area 460 that accommodates spring lock 450 when blade 428 is nested within channel 304 such that spring lock 450 is in an essentially neutral position. As blade 428 is withdrawn from channel 304, as in Fig. 29, curved end 462 of pivot end 444 rides along spring lock 450, pushing spring lock plate 456 to the right, against biasing spring 452. Once blade 428 is fully withdrawn, as shown in Fig. 30, spring lock 450 returns to an essentially neutral position as spring lock plate 456 comes to rest in notch 464 of pivot end 444. In the fully withdrawn position, notch 464 and spring lock 450 prevent rotation of blade 428 back into channel 304 without first moving spring lock 450 out of the way, i.e., to the right, against biasing spring 452. Thus, an inadvertent closure of blade 428 is prevented. As in the embodiment of Figs. 22-24, pivot end 444 is also provided with a notch 448 in which resilient end 442 of spring 440 rests when blade 428 is fully extended. Resilient end 442 and notch 448 prevent further rotation of blade 428 out of channel 304 so that force applied to blade 428 may be transmitted to the workpiece. Blade 428 can now only be retracted into channel 304 by first moving spring lock 450 and spring plate 456 to the right, against biasing spring 452, and thus out of notch 464 and thereafter pivoting blade 428 into channel 304. Curved end 462 can thus slide along spring lock plate 456,

as shown in Fig. 29, and blade 428 may be returned to its nested position within channel 304.

The handles of the multi-tool of the present invention may be formed by any desired process, such as
5 extrusion, or molding, or stampings, and out of any desired material, such as plastic or stainless steel. The front and back surfaces of the handles may further be textured and the above-described rulers may be formed in the basic structural material of the multi-tool or from separate aluminum or
10 plastic pieces coupled to the handles in any desired manner. Upon comparison of multi-tool 212 of Fig. 21 and multi-tool 212' of Fig. 26, it may be seen that the handles of the multi-tool of the present invention may be formed as either a one-piece unit or a two-piece unit, as will now be de-
15 scribed. It will be understood that the description of the handles of these embodiments is also applicable to multi-tool 12.

Handles 220, 222 of multi-tool 212 shown in Fig. 21 are formed essentially as a one-piece unit. A cross-
20 section of handle 222, along line 31-31 of Fig. 22, illustrating the formation of handle 222 as a one-piece unit is shown in Fig. 31. As may be seen in Fig. 31, top surface 252, second side 262, and bottom surface 253 form a substantially one-piece handle 222.

25 Alternatively, handles 220', 222' may be formed from two overlapping pieces, as shown in Figs. 26, 32, and 33. As may be seen upon comparing Fig. 32 with Fig. 22, which essentially are the same cross-sectional view through one of the handles of a multi-tool of the present invention, second side 262' of two-piece handle 222' is formed as an
30 overlap of a portion of bottom surface 253' and second side 262', whereas second side 262 of handle 222 is substantially uniform. The overlap of second side 262' of handle 222' may be seen, more easily, in Fig. 33. Bottom surface 253' has a
35 bent edge 253'' that overlaps second side 262' and facilitates bonding of the two halves of handle 222'. Preferably, second side 262' is closest to springs 440, as shown, to provide support for springs 440.

From the foregoing description, it will be clear that the present invention may be embodied in other specific forms, structures, arrangements, proportion, and with other elements, materials, and components, without departing from the spirit or essential characteristics thereof. One skilled in the art will appreciate many modifications of structure, arrangement, proportions, materials, and components, and otherwise, use in the practice of the invention, which are particularly adapted to specific environments and operative requirements without departing from the principles of the present invention. The presently disclosed embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims, and not limited to the foregoing description.

WHAT IS CLAIMED IS:

- 1 1. A multiple function tool comprising:
2 a first handle having a front and bottom sur-
3 face, first and second sides facing opposite directions and
4 first and second channels defined in said first and second
5 sides, respectively;
6 a second handle having a front and bottom
7 surface, first and second sides facing opposite directions
8 and first and second channels defined in said first and
9 second sides, respectively;
10 a tool head having first and second jaw
11 members pivotable about a tool head pivot axis, said first
12 jaw member pivotally connected to said first handle and said
13 second jaw member pivotally connected to said second handle;
14 at least one additional tool pivotally con-
15 nected to one of said first and second handles; wherein:
16 in a folded configuration, said first chan-
17 nels face each other, said tool head is in a storage posi-
18 tion within said first channel, and said second channels
19 face away from each other such that said at least one addi-
20 tional tool is accessible to be pivoted in and out of said
21 second channel of said one of said first and second handles;
22 and
23 in an unfolded configuration, said first
24 channels face away from each other so that said jaw members
25 are pivoted outside said first channels, and said second
26 channels face each other so that said at least one addi-
27 tional tool is not accessible.
- 1 2. A multiple function tool as in claim 1,
2 wherein said at least one additional tool comprises at least
3 one tool in said second channel of each of said first and
4 second handles.
- 1 3. A multiple function tool as in claim 1,
2 wherein said tool head is a plier head.
- 1 4. A multiple function tool as in claim 1,
2 wherein said first and second jaw members are respectively

3 pivotally connected to said first and second handles along
4 pivot axes that are substantially parallel to said tool head
5 pivot axis.

1 5. A multiple function tool as in claim 1,
2 wherein:
3 said first handle has a first longitudinal
4 axis;
5 said second handle has a second longitudinal
6 axis;
7 said first and second handles have a combined
8 longitudinal axis in said folded configuration, said com-
9 bined longitudinal axis being positioned between said first
10 and second longitudinal axes;
11 said at least one additional tool is pivotal-
12 ly connected to said first handle;
13 said at least one additional tool has a
14 longitudinal working axis and is shaped such that said
15 longitudinal working axis is positioned between said first
16 axis and said combined longitudinal axis.

1 6. A multiple function tool as in claim 5,
2 wherein said at least one additional tool includes at least
3 one additional tool in each of said first and second han-
4 dles.

1 7. A multiple function tool as in claim 1,
2 wherein each of said first and second handles further com-
3 prises a grip surface adjacent said first channel.

1 8. A multiple function tool as in claim 1,
2 wherein said first channel of each of said first and second
3 handles further include a jaw pocket for holding said jaw
4 members of said tool head.

1 9. A multiple function tool as in claim 8,
2 wherein said jaw pocket of each said handle further includes
3 a surface for facilitating folding and sliding of said jaw

4 members within said jaw pocket.

1 10. A multiple function tool as in claim 9,
2 wherein said jaw pocket of each said handle is inclined to
3 facilitate folding and sliding of said jaw members within
4 said jaw pocket.

1 11. A multiple function tool as in claim 1,
2 further comprising a ratchet.

1 12. A multiple function tool as in claim 11,
2 further comprising an adapter fitting in said ratchet, said
3 adapter formed to accept additional tools for ratcheting
4 with said ratchet.

1 13. A multiple function tool as in claim 1,
2 further comprising an adapter, said adapter being shaped to
3 fit on said at least one additional tool to accept further
4 tools mounted on said at least one additional tool.

1 14. A multiple function tool as in claim 1,
2 wherein one of said front and bottom surfaces of said first
3 and second handles has a ruler inscribed thereon.

1 15. A multiple function tool as in claim 14,
2 wherein both of said front and bottom surfaces of said first
3 and second handles have a ruler inscribed thereon, each
4 ruler being in a different measuring system.

1 16. A multiple function tool as in claim 14,
2 wherein said ruler is inscribed adjacent one of said first
3 and second sides, and said one of said first and second
4 sides is formed as a straight free edge.

1 17. A multiple function tool as in claim 1,
2 further comprising:
3 a plurality of additional tools pivotal into
4 and out of said second channels; and

5 a spring corresponding to each additional
6 tool, said spring preventing movement of said tools out of
7 said second channels beyond a working position.

1 18. A multiple function tool as in claim 17,
2 further comprising a locking mechanism for locking a select-
3 ed additional tool in a working position.

1 19. A multiple function tool as in claim 18,
2 wherein:

3 each additional tool has a pivot end pivotal-
4 ly connected to one of said first and second handles;

5 each pivot end has a notch defined therein;
6 and

7 said locking mechanism fits within said notch
8 in said pivot end to prevent movement of said tools out of
9 said second channels beyond the working position.

1 20. A multiple function tool as in claim 19,
2 wherein said locking mechanism further comprises a locking
3 plate and a biasing spring, said biasing spring biasing said
4 locking plate into position within said notch.

1 21. A multiple function tool as in claim 17,
2 wherein said springs are formed from a one-piece member.

1 22. A multiple function tool as in claim 1,
2 wherein said front and bottom surfaces and said first and
3 second sides of each of said first and second handles are
4 formed as a one-piece unit.

1 23. A multiple function tool as in claim 1,
2 wherein each of said first and second handles is formed from
3 two pieces coupled together.

1 24. A tool set comprising:
2 a multiple function, foldable tool having
3 first and second handles, said handles defining a first

4 storage channel and a second storage channel, said foldable
5 tool further including a jaw member pivotally mounted to
6 said handles for movement between a usable, extended posi-
7 tion and a storage position within said first storage chan-
8 nel, and at least one additional tool pivotally mounted one
9 of said handles for movement between a usable, extended
10 position and a storage position within said second storage
11 channel; and

12 an adapter set including a plurality of tool
13 heads shaped to fit within said adapter and an adapter
14 having a first end shaped to fit on said at least one addi-
15 tional tool and a second end shaped to accept one of said
16 tool heads.

1 25. A tool set as in claim 24, further including
2 a case for holding said multiple function, foldable tool and
3 said adapter set.

1 26. A foldable tool comprising:

2 a tool head having first and second jaw
3 members pivotally connected about a jaw pivot;

4 first and second handles pivotally connected
5 to said first and second jaw members, respectively, each of
6 said first and second handles having a first surface that is
7 gripped during use of said tool head and a second surface
8 facing a direction opposite said first surface, a first
9 channel being defined in each of said first surfaces and a
10 second channel being defined in each of said second surfac-
11 es; and

12 at least one additional tool pivotally con-
13 nected to one of said first and second handles, said at
14 least one additional tool fitting within said second channel
15 of said one of said first and second handles.

1 27. A foldable tool as in claim 26, wherein said
2 jaw members are pivotable about said first and second han-
3 dles to fit within said first channels of said first and
4 second handles.

1 28. A multiple function tool comprising:
2 a first handle having a first channel;
3 a second handle having a first channel;
4 a plurality of tools each having a pivot end
5 pivotally connected to at least one of said first and second
6 handles, said plurality of tools being pivotable between a
7 storage position within said first channels and a working
8 position outside said storage position; and
9 a spring for each of said plurality of tools;
10 wherein:
11 a notch is defined in each pivot end; and
12 each said spring has a resilient end fitting
13 within said notch of a corresponding tool, said resilient
14 end preventing movement of said tool beyond said working
15 position.

1 29. A multiple function tool as in claim 28,
2 further comprising a locking mechanism for locking a select-
3 ed tool in a working position.

1 30. A multiple function tool as in claim 29,
2 wherein:
3 a locking notch is defined in said pivot end
4 of each said tool; and
5 said locking mechanism fits within said
6 locking notch in said pivot end to prevent movement of said
7 tools out of said first channels beyond the working posi-
8 tion.

1 31. A multiple function tool as in claim 30,
2 wherein said locking mechanism further comprises a locking
3 plate and a biasing spring, said biasing spring biasing said
4 locking plate into position within said locking notch.

1/13

FIG. 1

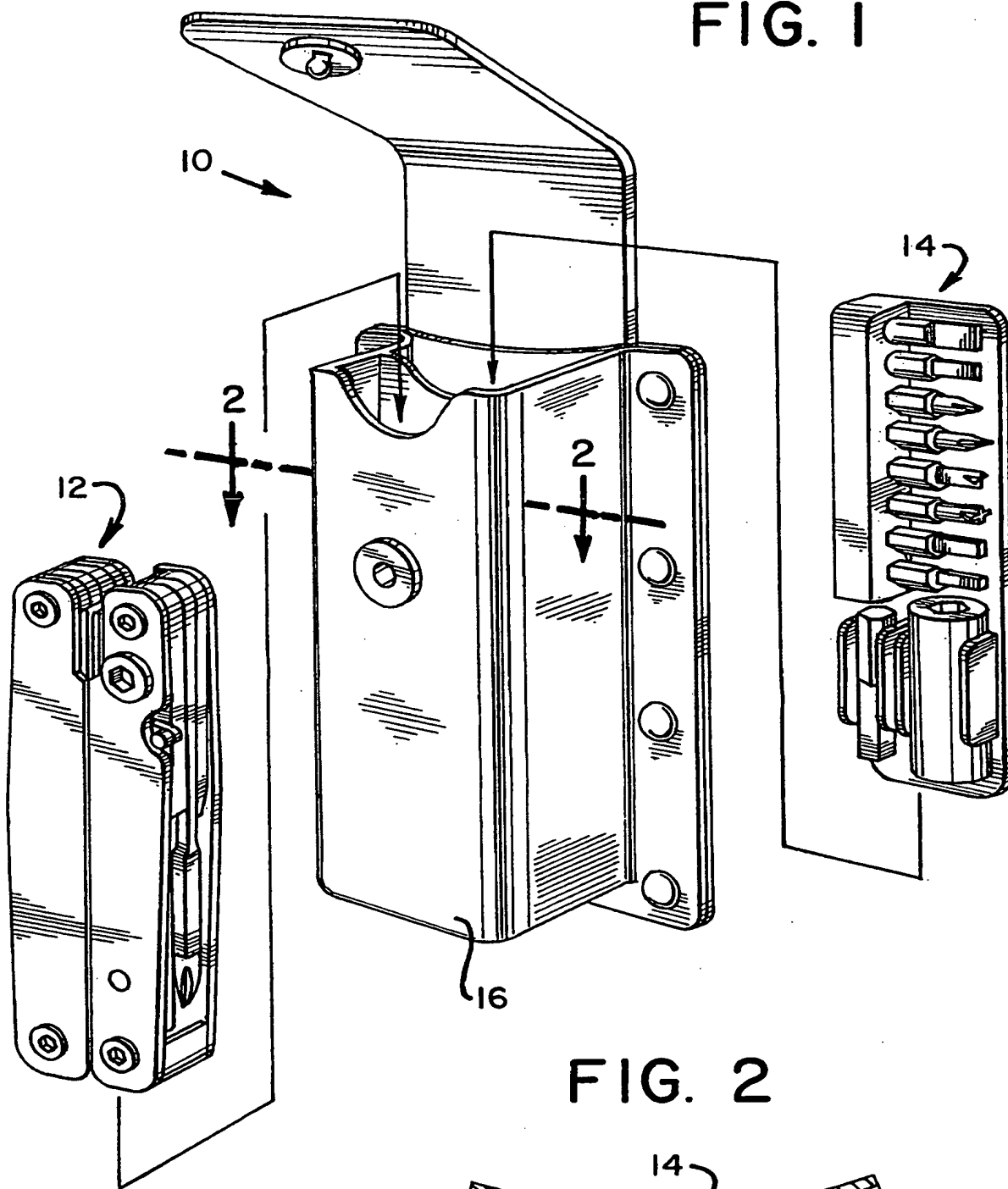
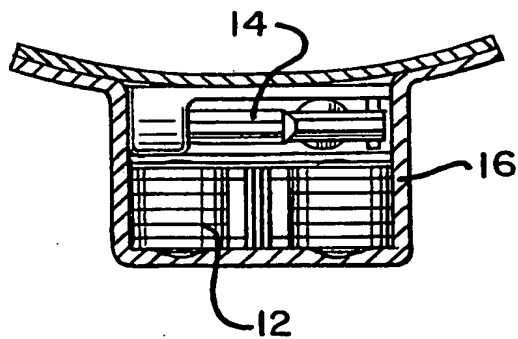
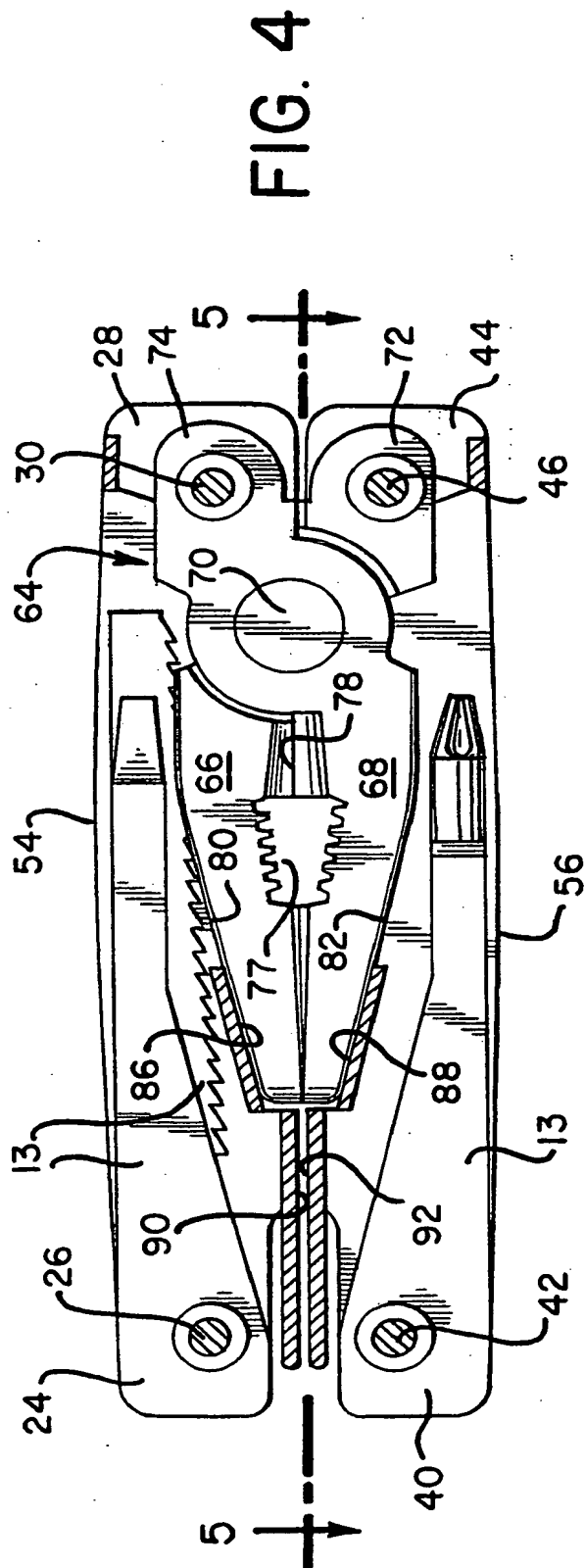
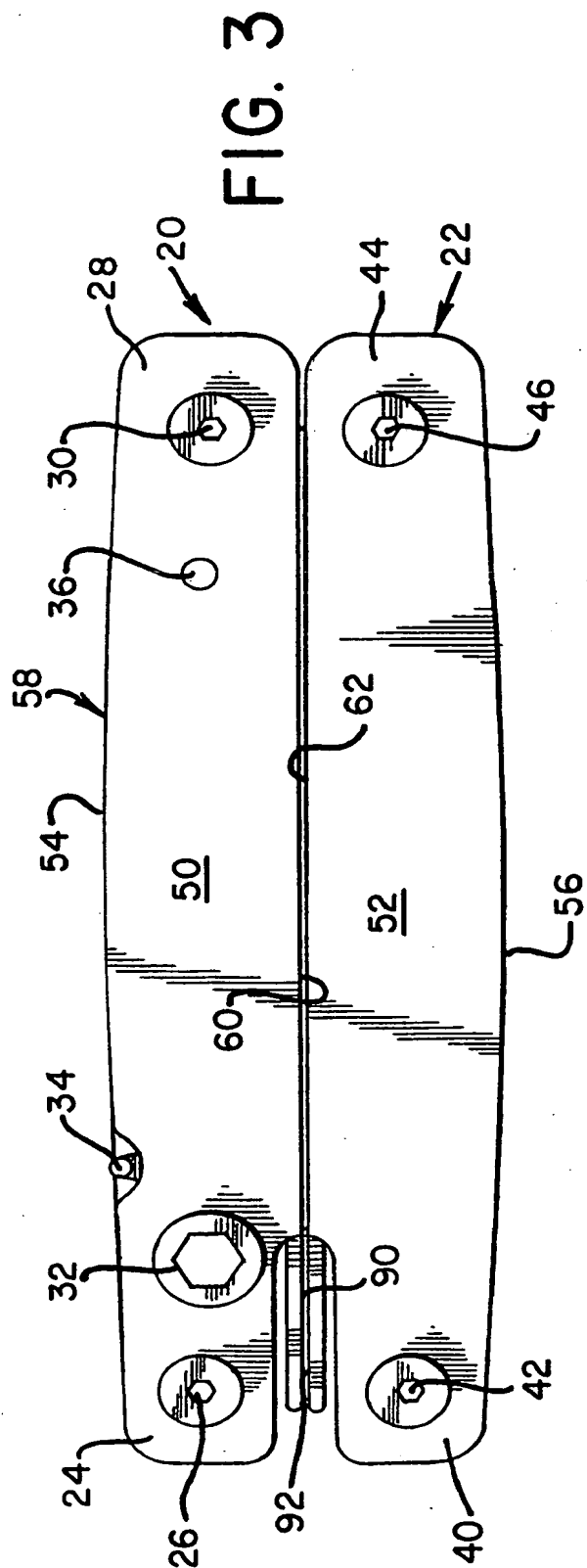


FIG. 2





3/13

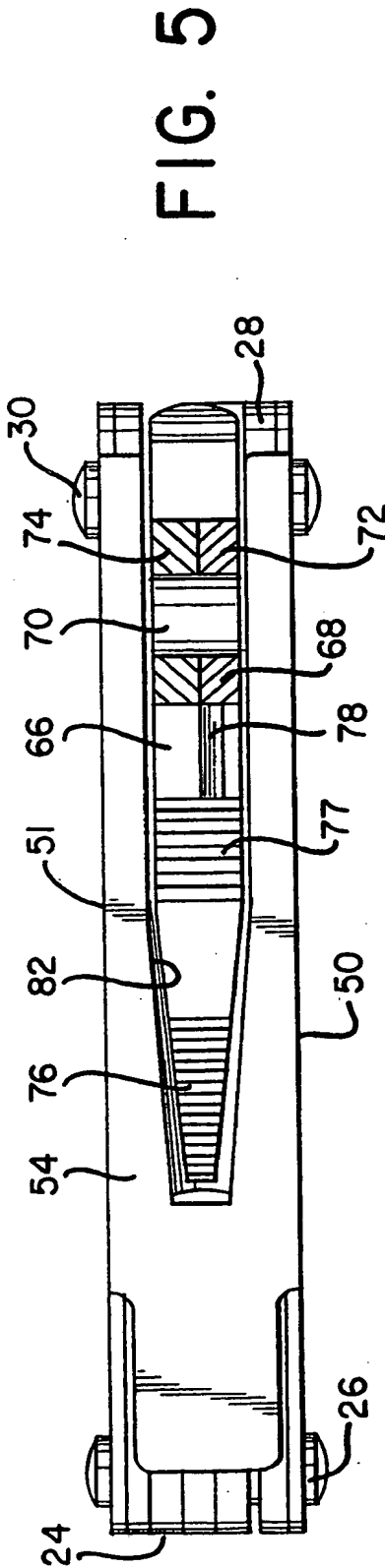


FIG. 6

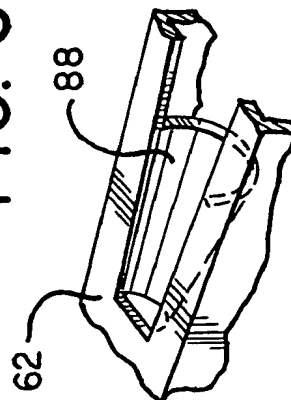
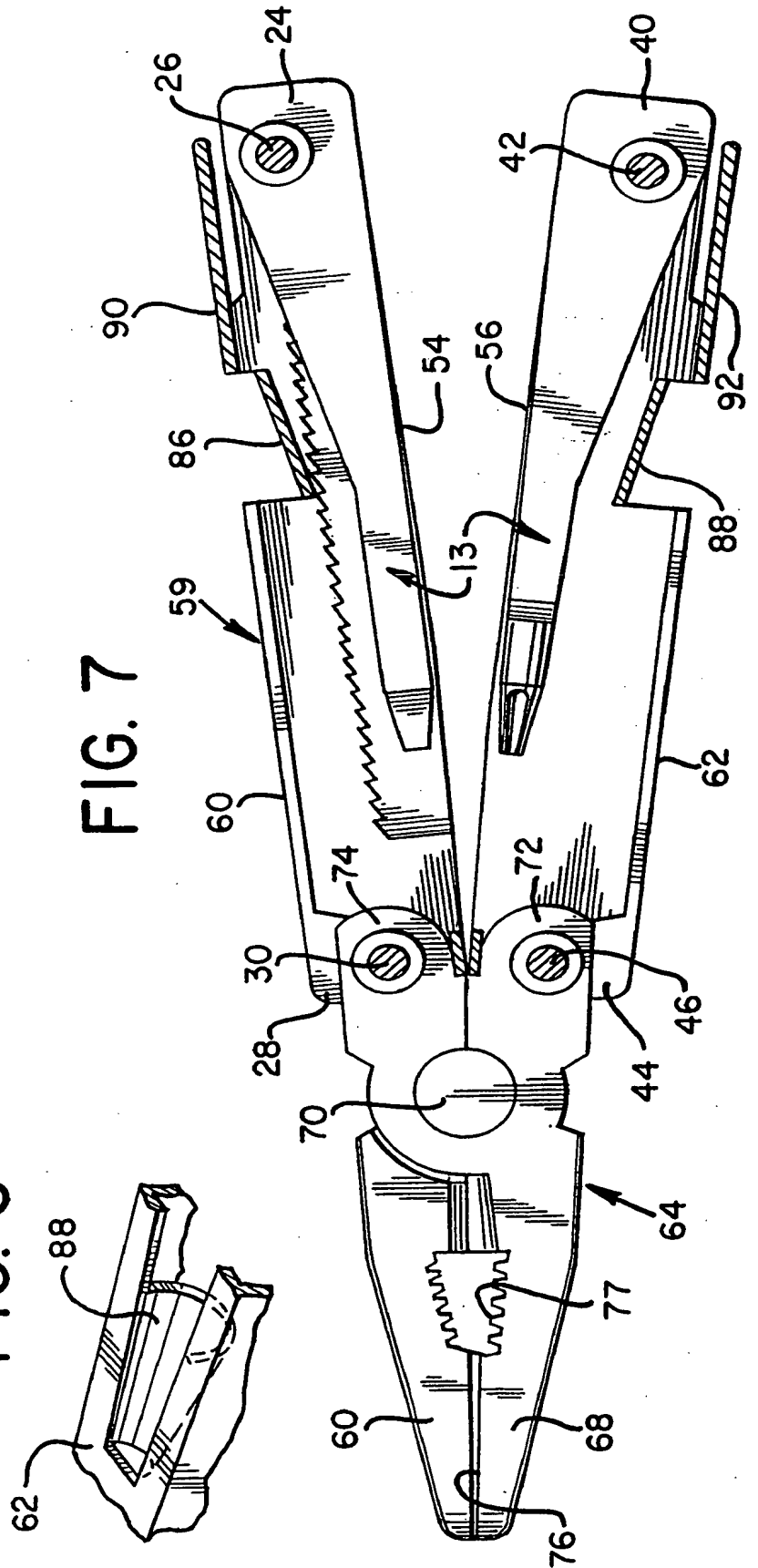


FIG. 7



4/13

FIG. 8

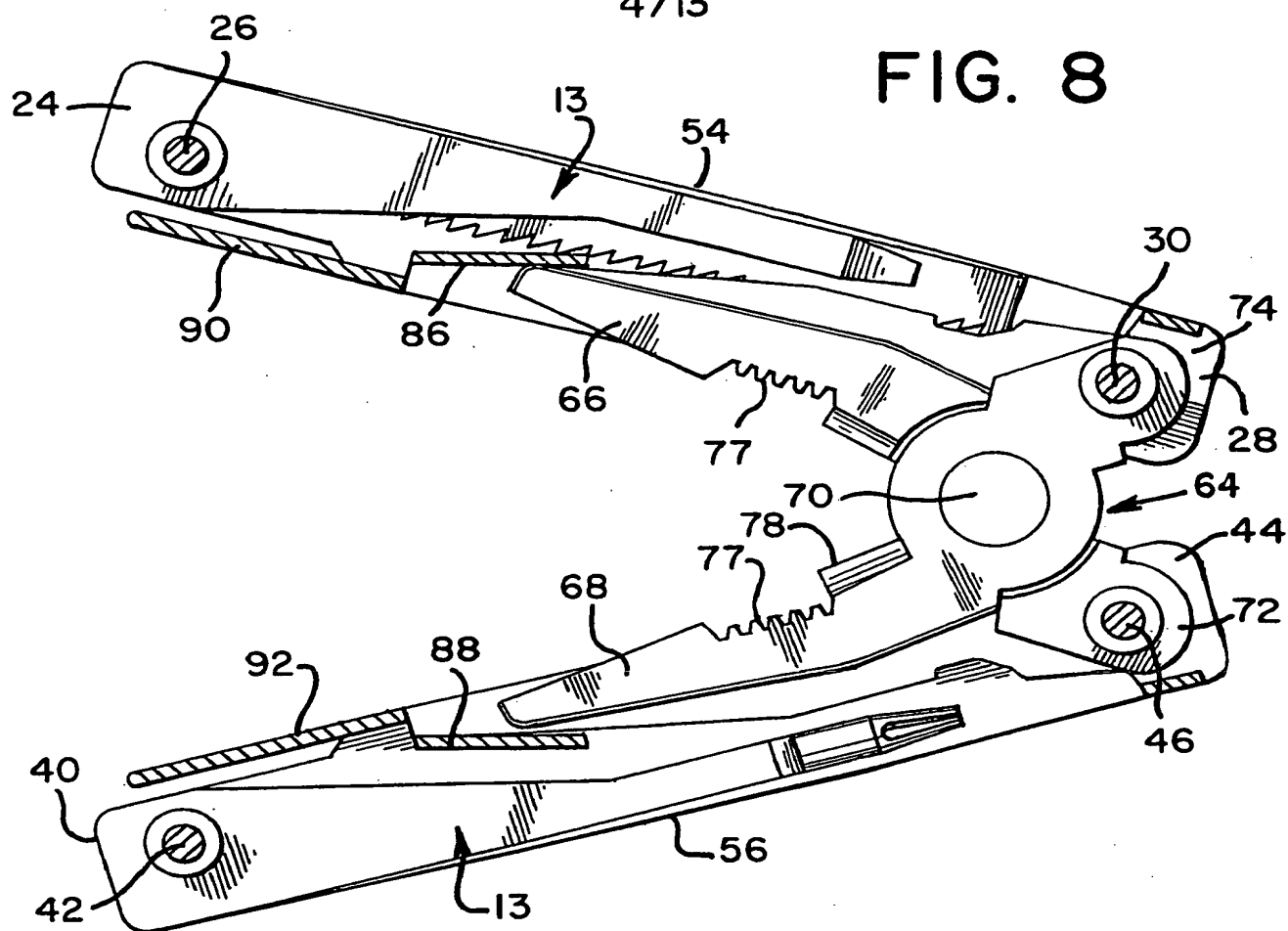


FIG. 9

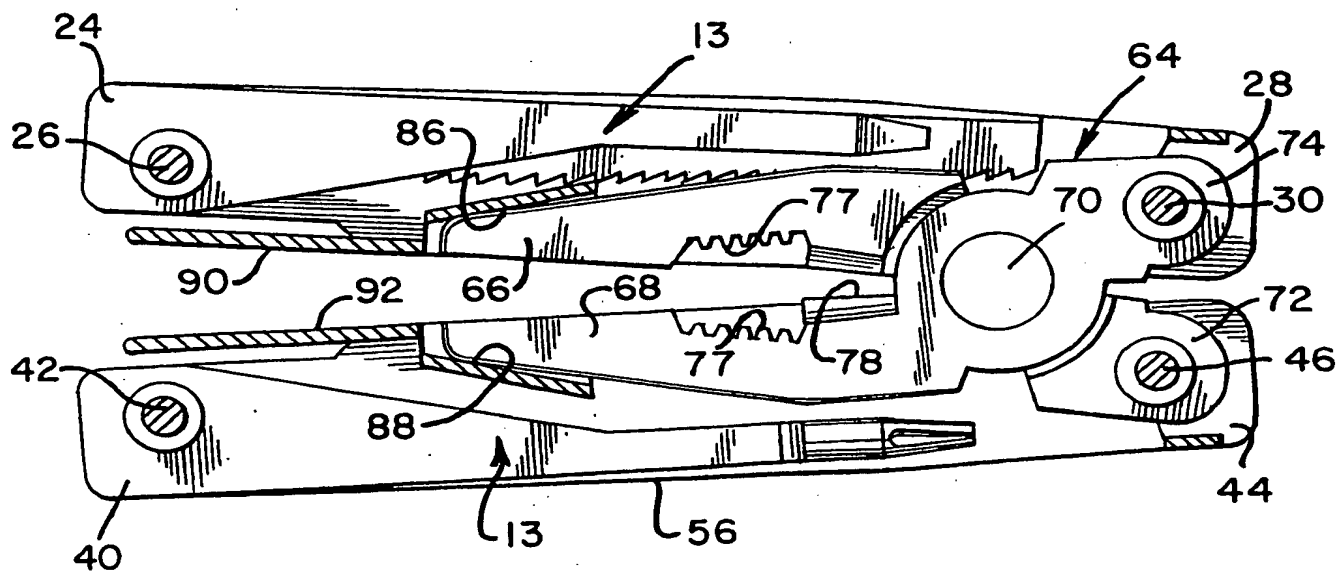


FIG. 10

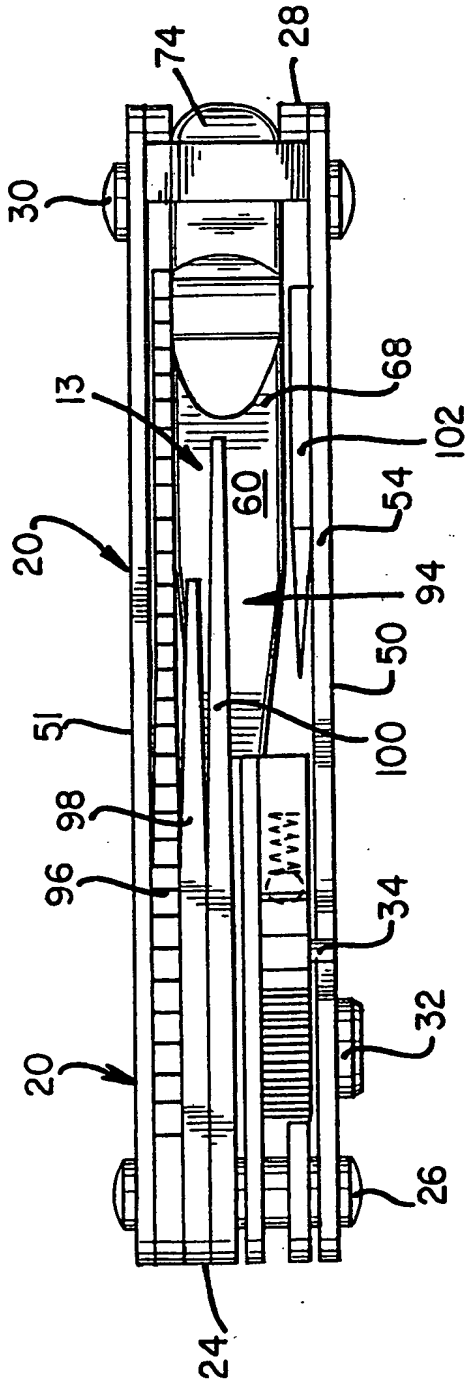
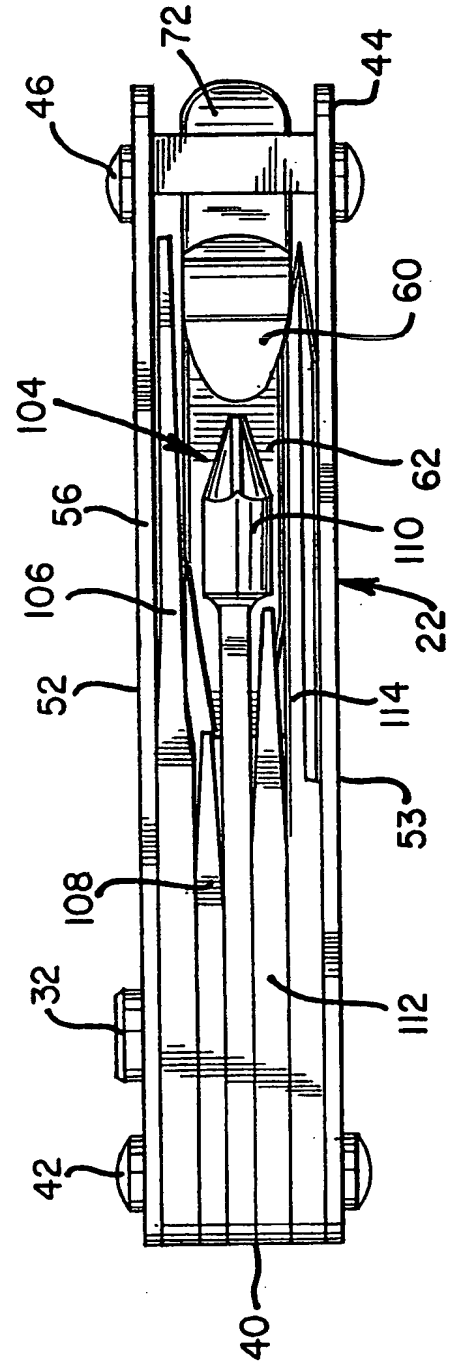


FIG. 11



[illegible]

FIG. 14

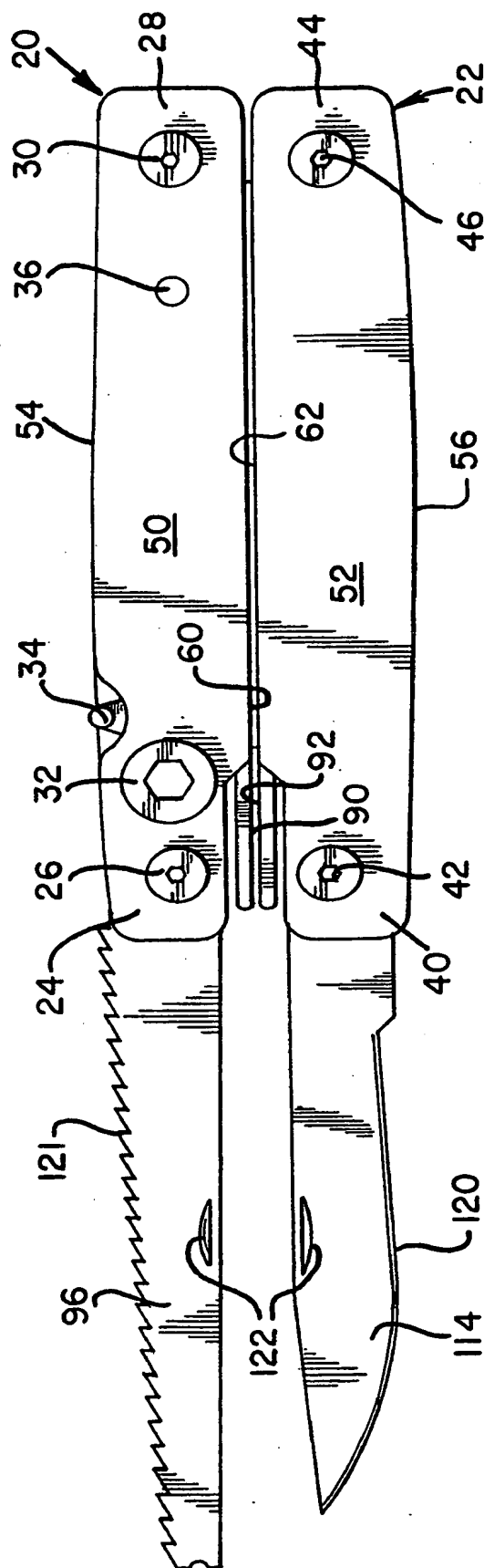
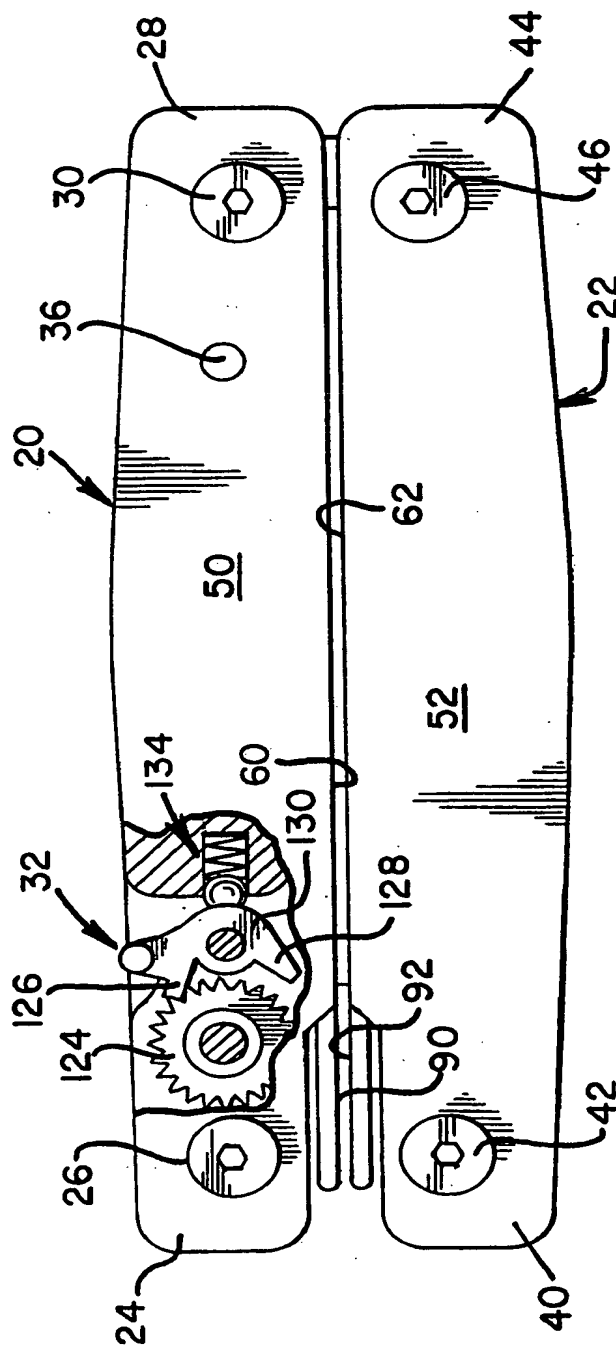


FIG. 15



8/13

FIG. 16

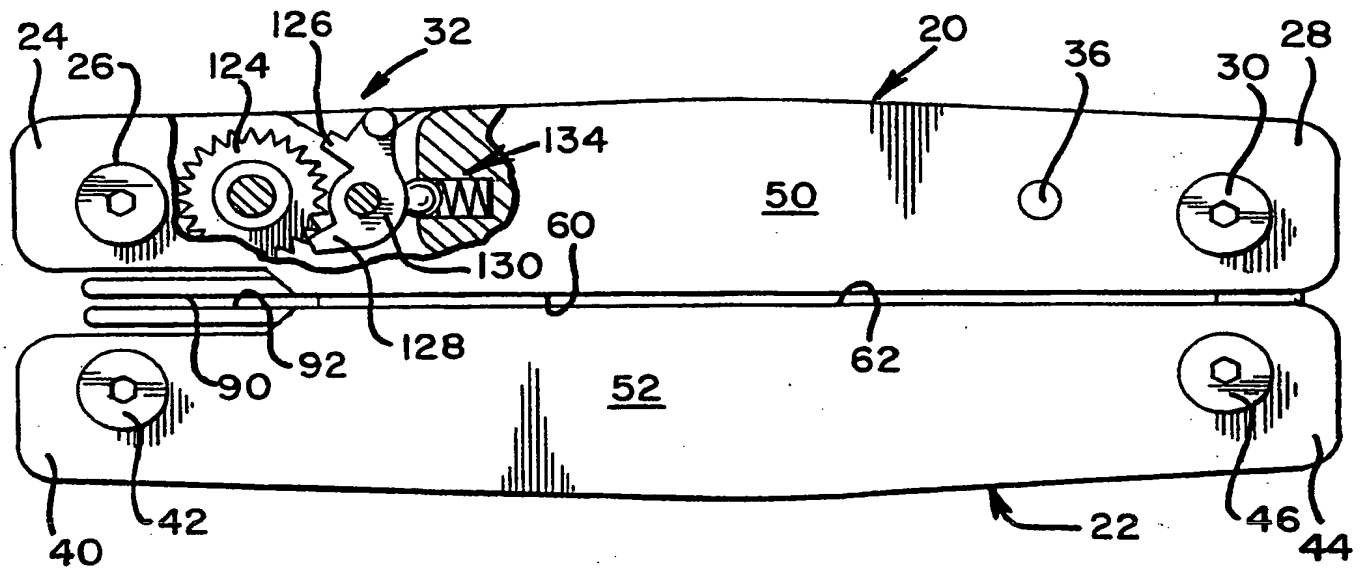
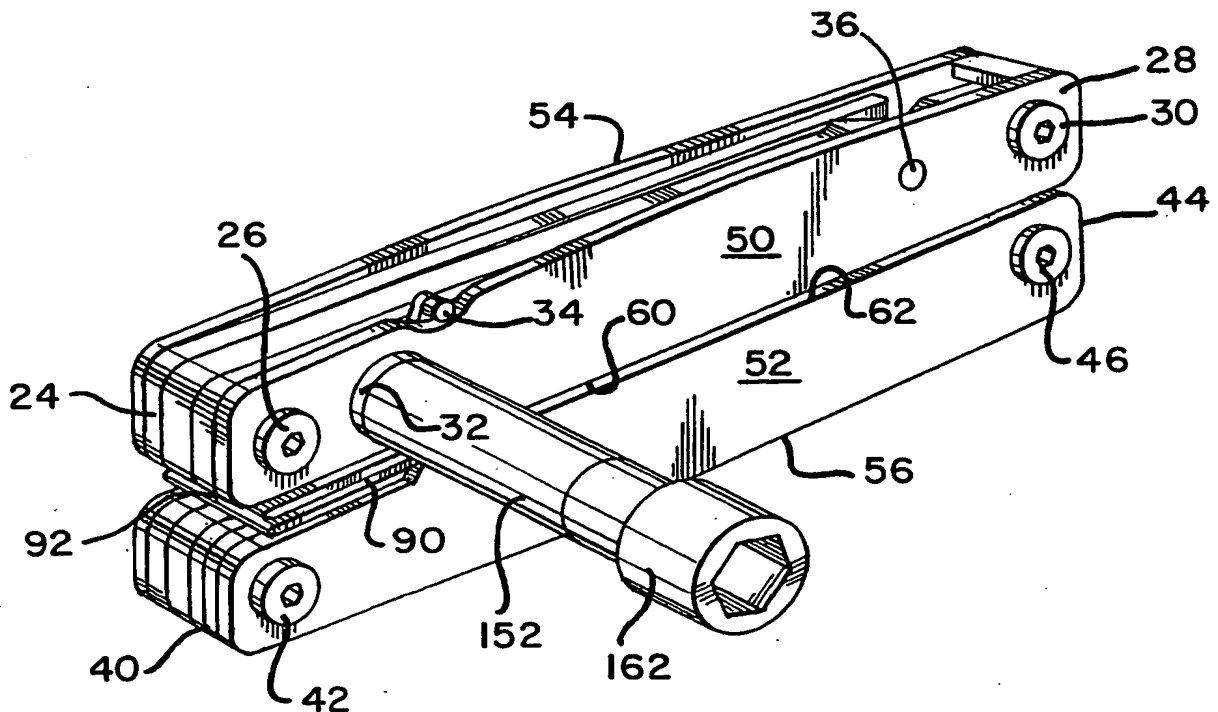
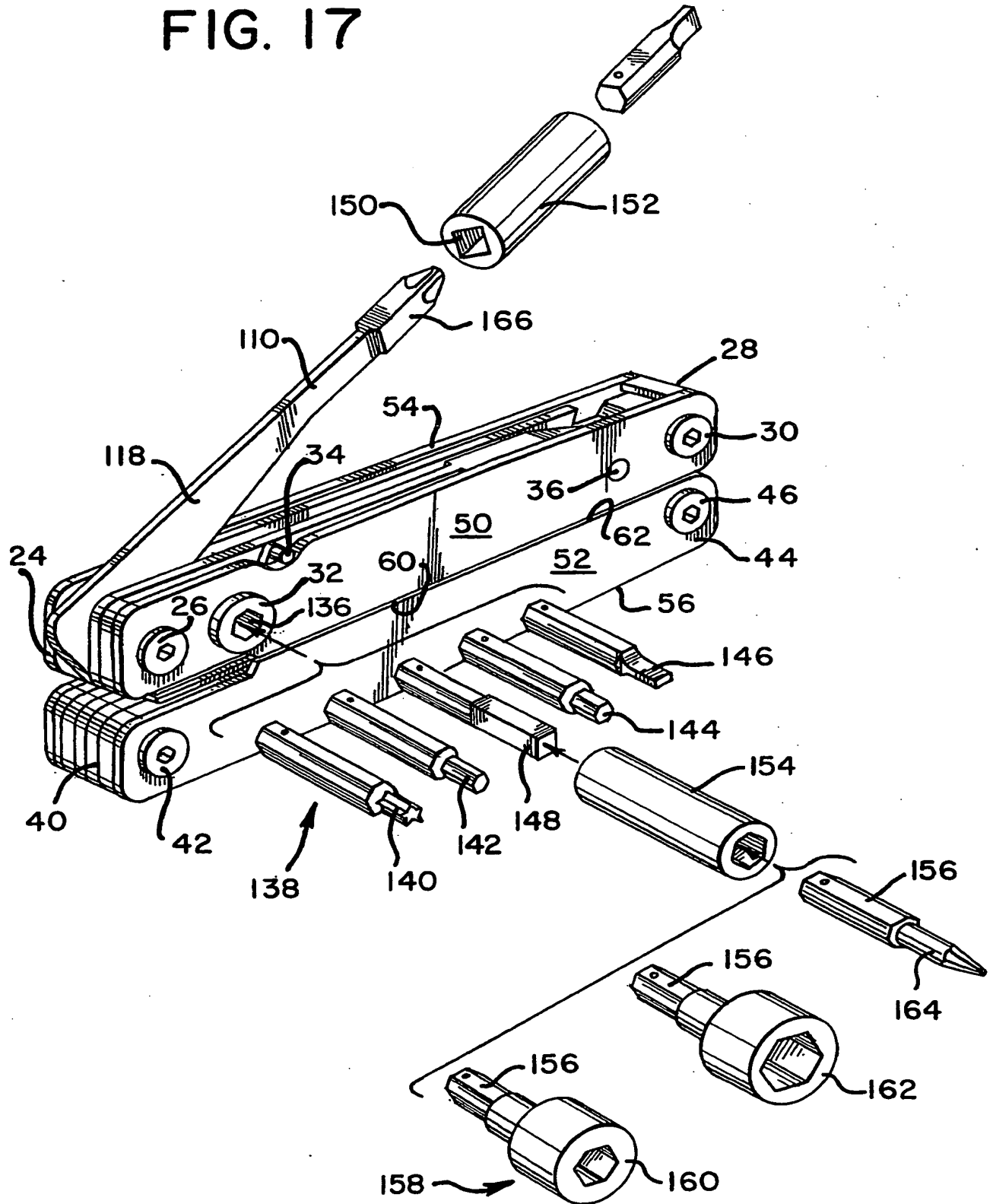


FIG. 18



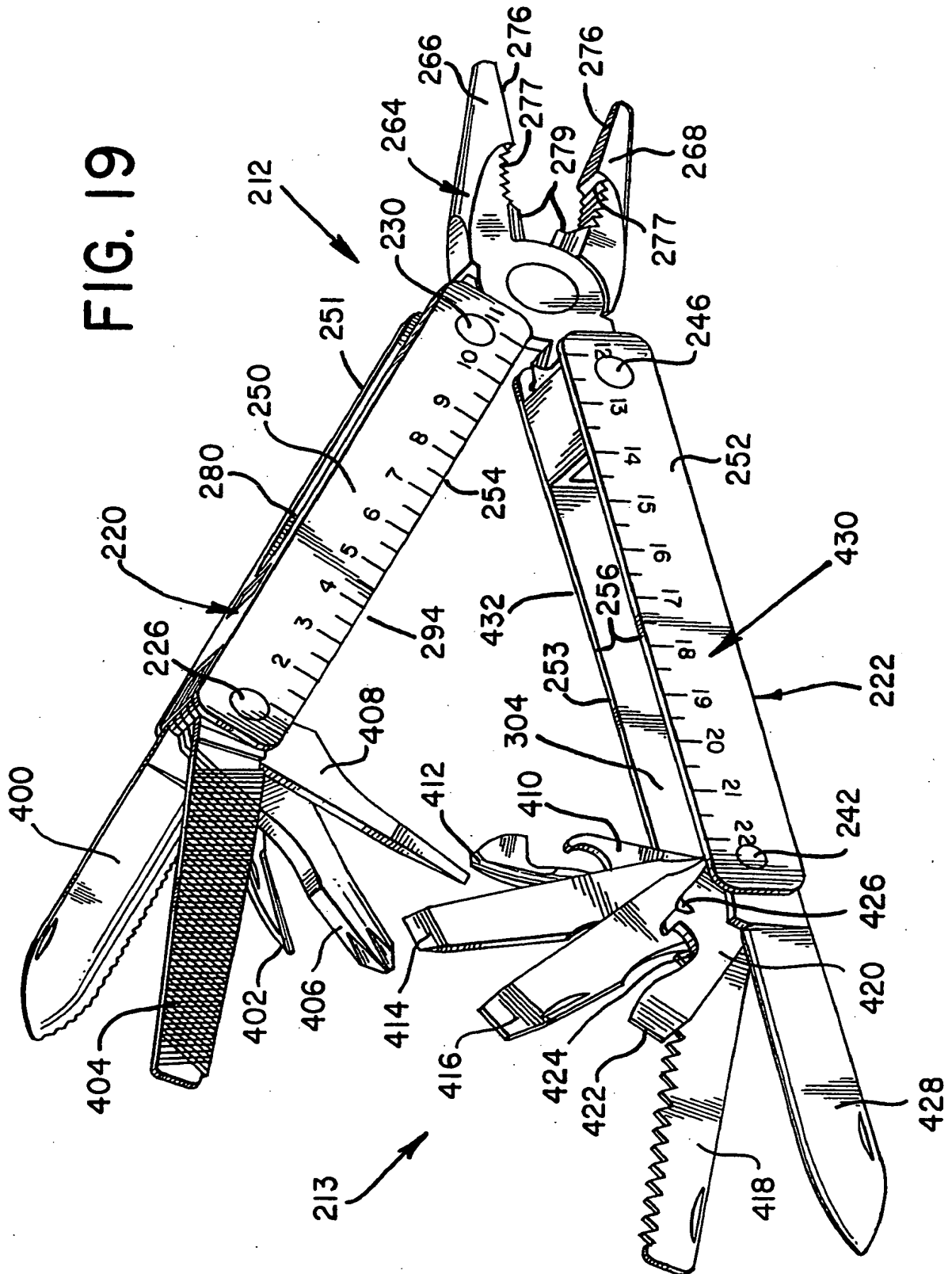
9/13

FIG. 17



10/13

FIG. 19



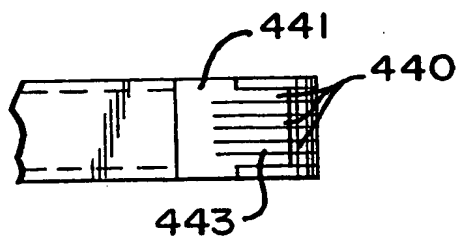
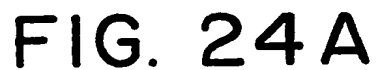


FIG. 31

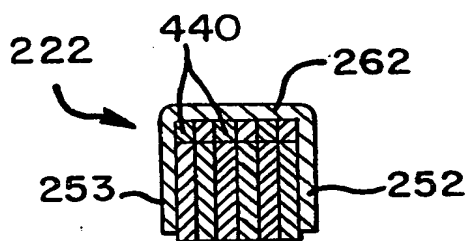


FIG. 33

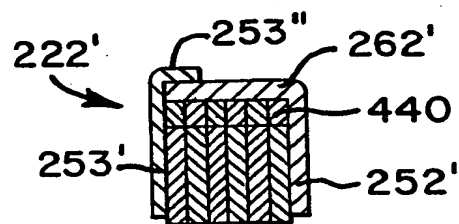


FIG. 24

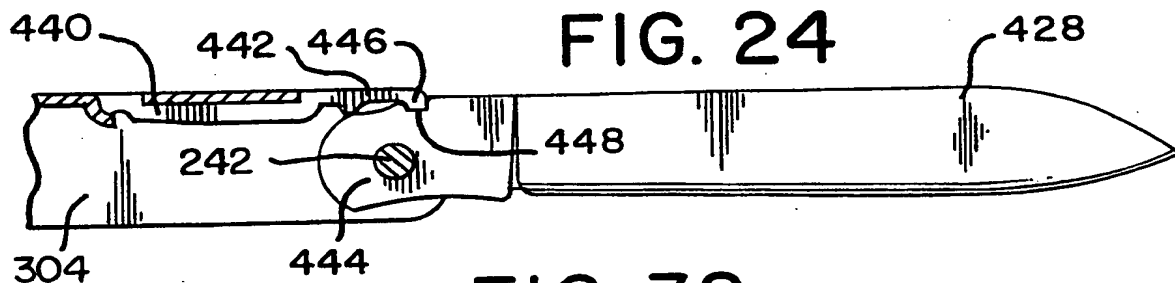


FIG. 32

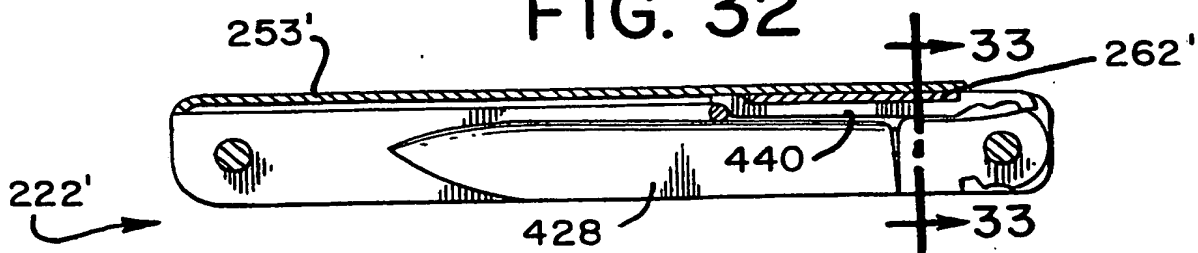


FIG. 20

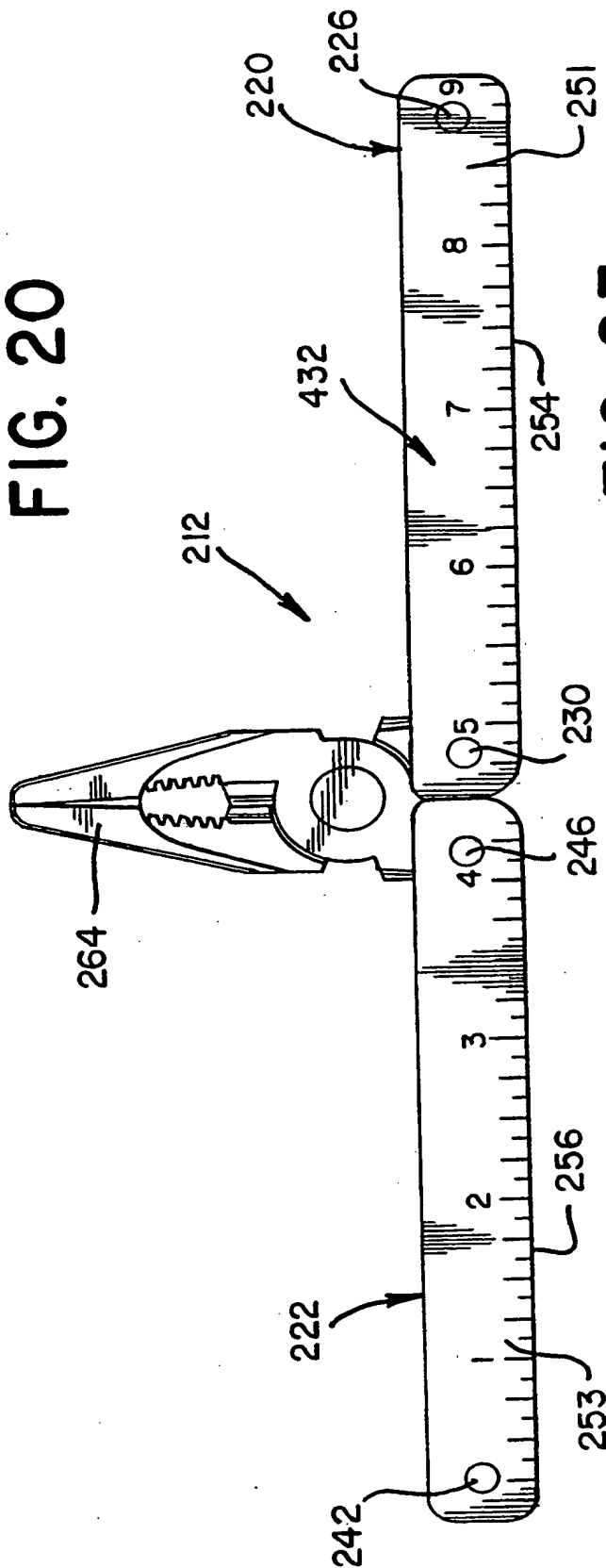


FIG. 23

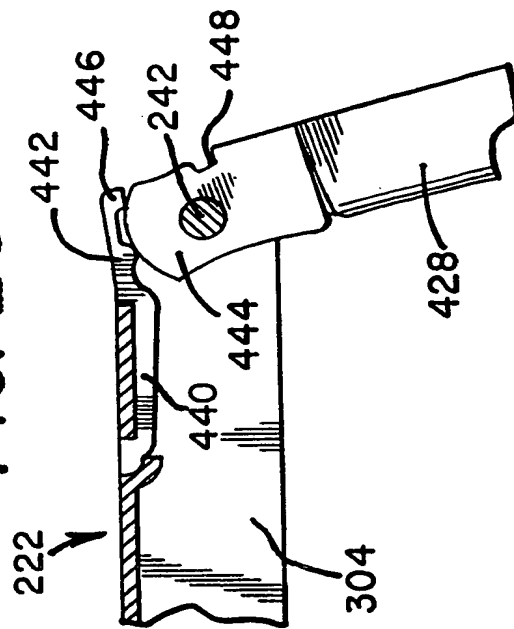
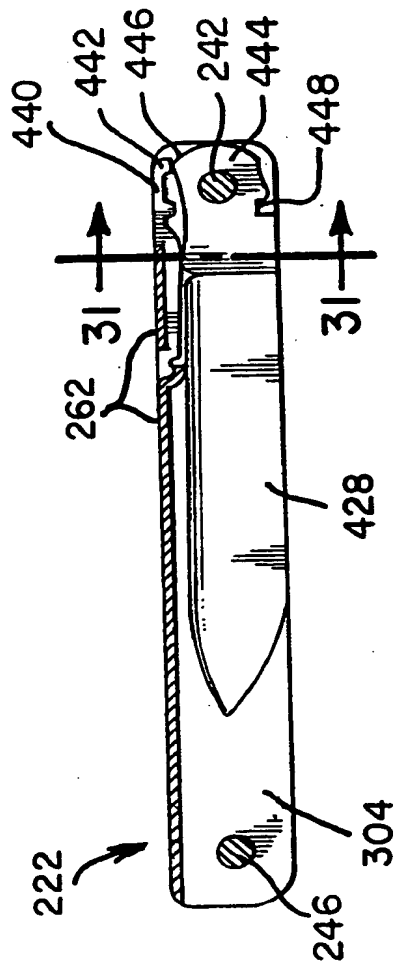


FIG. 22



13/13

FIG. 25

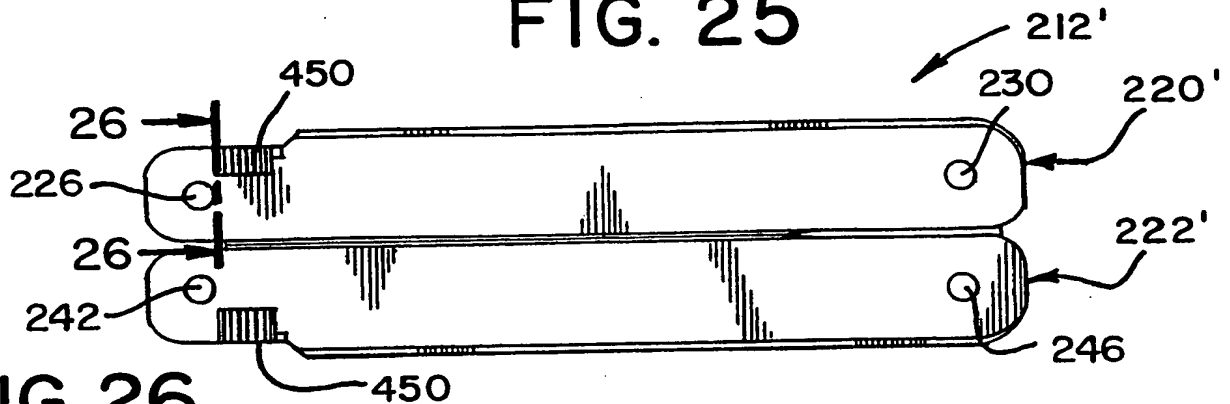


FIG. 26

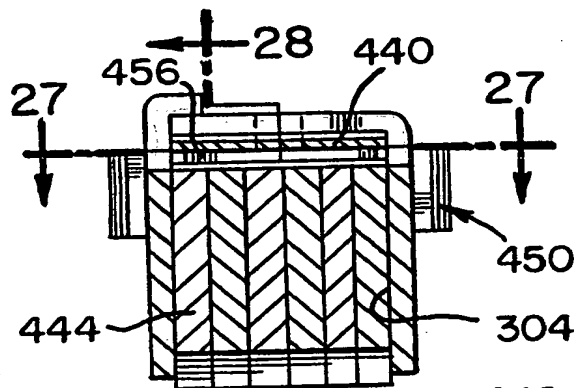


FIG. 27

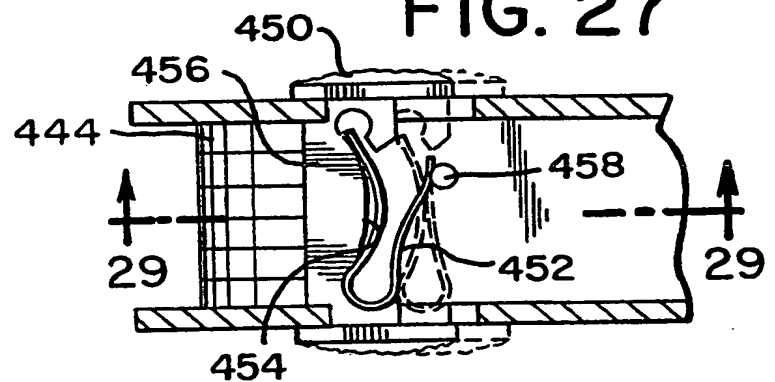


FIG. 29

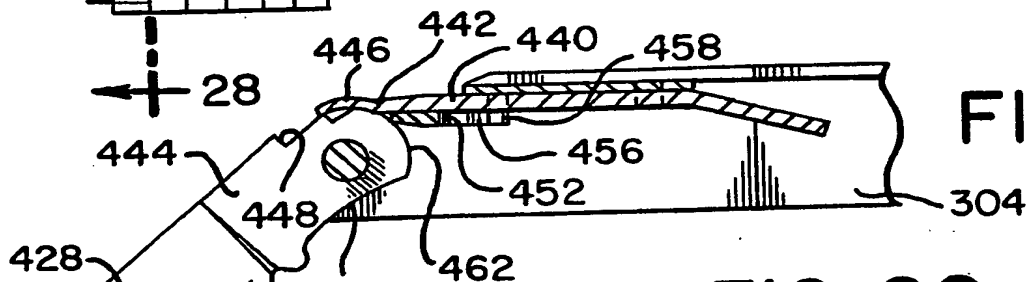


FIG. 28

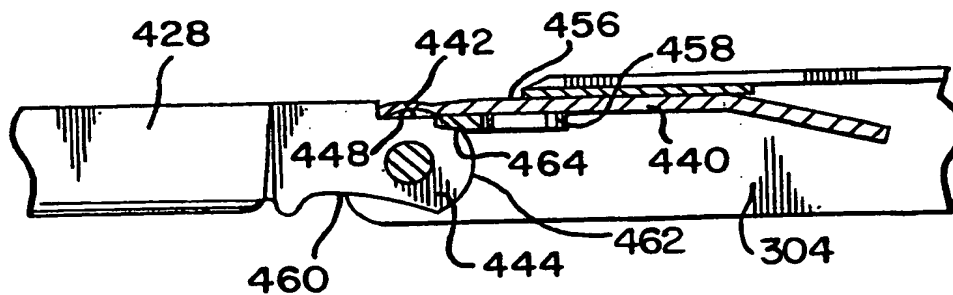
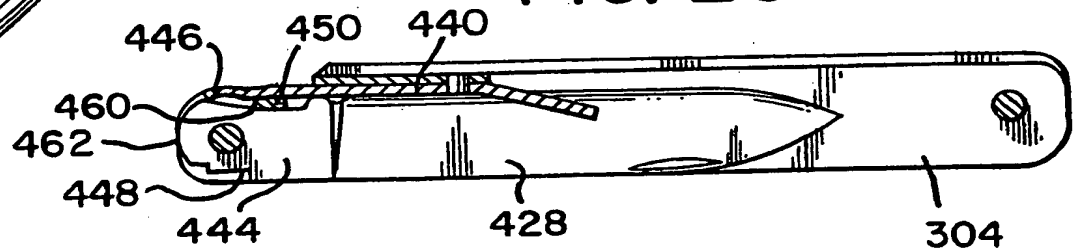


FIG. 30

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/02185

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B25B 7/22
US CL :7/129; 81/427.5; 30/153, 255
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 7/106, 125, 127, 128, 129; 81/415, 427.5; 30/153, 255

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,238,862 A (LEATHERMAN) 16 DECEMBER 1980, See entire document.	28-31
A	US 4,744,272 A (LEATHERMAN) 17 MAY 1988, See entire document.	1-31
A	US 5,119,520 A (FINN) 09 JUNE 1992, See entire document.	1-31
A	US 5,245,721 A (LOWE ET. AL.) 21 SEPTEMBER 1993, See entire document.	1-31

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
A document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
E earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*G* document member of the same patent family
O document referring to an oral disclosure, use, exhibition or other means	
P document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

17 APRIL 1997

Date of mailing of the international search report

12 MAY 1997

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

JAMES G. SMITH

Telephone No. (703) 308-1148

Sheila Veney
Paralegal Specialist
Group 3200

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.